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INSECTS IN RELATION
TO
NATIONAL DEFENSE

Circular 8

FLIES



June 1941

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INTRODUCTION

Flies of several species carry a number of diseases dangerous to man and animals, certain other species constitute only an annoyance. The maggots of others invade wounds or the alimentary and urinogenital tracts. The different kinds which directly affect man may be divided roughly into two groups--the biting, or blood-sucking forms, and the non-biting ones. The biting flies may be very annoying and may occasionally transmit such diseases as anthrax and tular-emia; however, the non-biting flies, of which the housefly is a typical example, are of greater importance because they carry organisms that cause diseases--such as typhoid, dysentery, and diarrhea--or the eggs and younger stages of parasitic worms. Certain species of flies are treated in separate circulars (see Circular 16, Horsebots; Circular 17, Stable Flies; and Circular 18, Screw-worms).

THE HOUSEFLY

The housefly, Fig. 1, easily takes first rank among the non-biting flies because of its

great disease-carrying potentialities, its abundance, and its wide distribution.



Figure 1 - The common housefly, female.

LIFE HISTORY AND HABITS

The whitish elongate eggs, Fig. 2, are laid in masses on the breeding media. They hatch in 12 to 24 hours, and the maggots, or larvae, Fig. 3, feed on the material on which the eggs were laid, reaching full size (about $\frac{2}{3}$ of an inch long) in from 4 days to several weeks, depending on temperature. When full-grown they move away from the moist parts of the breeding material until they reach comparatively dry quarters. These may be in the outer portions of the breeding material or in the soil or debris nearby. Here they pupate, and from the barrel-shaped reddish

brown puparia, Fig. 4, the adults emerge in 3 to 6 days in summer. The adult flies expand their wings until fully developed and dry, and usually move about and feed for 3 to 4 days prior to mating and egg laying.

In the region of Washington, D. C. individual female houseflies during a normal lifetime in summer of 2 to 12 weeks, deposit 2 to 4 egg masses, each containing on the average about 130 eggs. In Panama a single fly has been recorded as depositing 2,367 eggs in 21 batches.

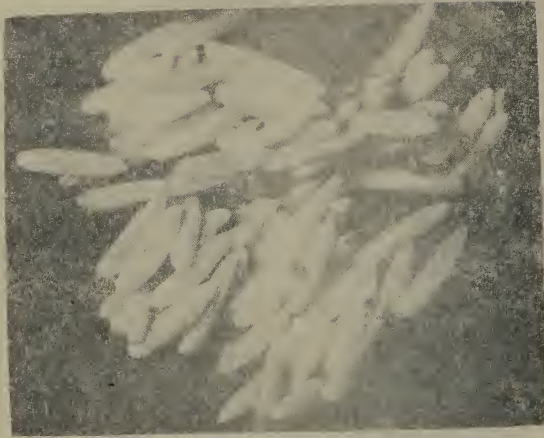


Figure 2 - Eggs of housefly.

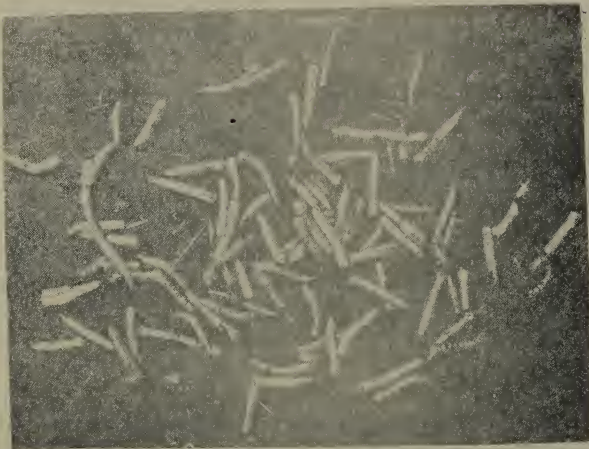


Figure 3 - Housefly maggots, or larvae.



Flies probably do not travel far if food is abundant; however, it has been shown in experiments that they may travel as far as 13 miles from the point of liberation. As adults the flies take food for the most part in liquid form, but flies can ingest minute objects and are known to ingest eggs of parasitic worms.

Figure 4 - Housefly pupae, or "sleepers."

CONTROL

Because of diverse habits and the wide variety of conditions under which they breed, there is no single line of attack which will insure lasting protection from houseflies. It is necessary to use several methods of combating this insect enemy to secure a modicum of success. The most important of these are measures designed to prevent fly breeding.

Prevention of Housefly Breeding

Manure disposal.--Manure, particularly that of horses and hogs, constitutes one of the principal breeding media of houseflies. Eggs are often laid on manure immediately after it is voided; all manure therefore should be considered as infested. Although large accumulations of manure are most productive of flies, soil contaminated with manure and urine may breed considerable numbers. This makes imperative the thorough daily cleaning of

stables and the soil along picket lines. Flies do not breed to any extent in well rotted manure. It is only during the period of fermentation that they are attracted to it for egg laying.

Where practical, the manure should be hauled away every third day and spread out thinly over fields. This dries it out quickly and kills the fly eggs and larvae contained in it.

Incineration is also an effective way of disposing of both manure and immature stages of the fly, if facilities are available for its practice, but of course valuable fertilizing material is thus destroyed.

In the case of a small number of horses, the manure may be temporarily stored in manure bins or pits. These should be as nearly fly tight as possible and should be fitted on top with conical fly traps to capture those flies that emerge. A horse produces about 10 pounds of manure a day where bedding is not used.

The large amounts of manure produced at remount stations are most satisfactorily handled by the ricking method of which there are several different modifications. All operate on the same principle, however. The simplest is to dump the manure in ricks about 8 feet wide and as long as necessary to accommodate the manure produced. The ricks should be short enough so that the entire surface will receive additional layers every day or two. It is essential that the material be compacted and that the sides of the ricks be kept nearly vertical. To accomplish this it is necessary to use care in dumping each load and to distribute it by hand.

The heat generated in the compacted rick either kills the fly larvae or drives them to the surface. There they may be killed by sprinkling

the sides and the top of the finished rick with borax solution (see page 8) or with crude oil. The heat generated in the ricks can be made effective against a larger percentage of the larvae and eggs if the ricks are covered for a few days after they are completed with old tarpaulins or large sheets of tarred burlap.

In the more permanent camps concrete bases are advisable upon which to rick the manure, Fig. 5. These may be of solid concrete with concrete

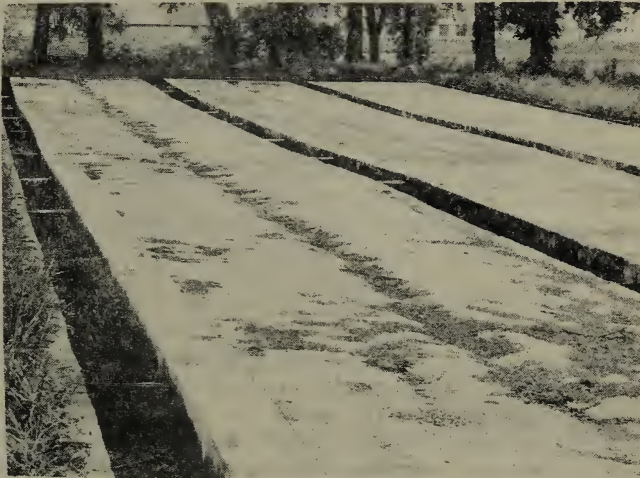


Figure 5 - Concrete base on which to rick manure.

trenches around the ricks, or the concrete may be limited to the trenches. After a rick is complete, a few inches of water should be put in the adjacent trenches. The larvae fall into these as they crawl out of the manure and are drowned. The addition of a heavy film of crankcase oil on the water aids in destroying the larvae.

Chemical treatment of manure.--Considering cost and effectiveness, borax is the most satisfactory material for use in treating manure to prevent fly breeding. It may be applied as a powder in rainy climates and in moist places. Under other circumstances it should be dissolved in water at the rate of 1 pound per gallon and sprinkled over the surface. When borax is used at the rate of 10 ounces per 10 bushels of manure, practically all fly larvae and their eggs are killed, and the manure is not injured for fertilizing the soil to promote growth of most of the crops ordinarily grown. Some plants are damaged if amounts of borax in excess of the above are applied, or if the manure is used in excess of 15 tons per acre.

Care and disposal of garbage.--Fermenting and neglected garbage furnishes an excellent medium for fly breeding. To prevent such breeding every kitchen should be well equipped with a sufficient number of covered garbage cans to take care of the daily output.

Garbage containers must be kept tightly covered. They should be thoroughly cleaned with hot water and a cleaning compound such as lye as soon as they are emptied. The containers should be conveniently placed, but should be at least 10 feet from the door. Elevated platforms to accommodate the cans are desirable for convenience and to protect the garbage from dogs, rats, and ants. The supports of the platform should be provided with oil cups or ant tape to exclude ants (Circular 15).

It is advisable to pick up the filled cans and replace them with clean ones, taking the filled cans to a central place for emptying.

The destruction of garbage by burning is the most sanitary method of disposing of it. The obnoxious odors produced by this method are a serious drawback. The odors may be reduced to a minimum by the use of a closed incinerator provided with a suitable stack. Temperatures of at least 1250° F. must be maintained to decompose the malodorous gases. Unfortunately, the installation of closed incinerators is expensive, costing about \$1,000 per unit ton capacity, and their use by small units is therefore not practical.

As emergency installations, open incinerators may be used, but they do not burn the gases and eliminate odors, and are therefore objectionable, especially if located near the camp or near towns. Semi-closed incinerators have low stacks and may be constructed of ordinary brick.

It is often economical to dispose of garbage under contract to hog feeders. Such contracts should require (1) daily removal of garbage, (2) the use of clean trucks, (3) suitable sanitation at the feeding end which should be located satisfactorily both with reference to the camp and civilian communities. The production of flies in an unsanitary hog-feeding establishment is so great that any military or civilian units within several miles may be heavily infested. At best, some fly breeding is likely to occur when garbage is being fed, and as pointed out, flies are capable of traveling several miles. Such plants should be located at least 2 miles from a cantonment.

Garbage, if kept well protected from flies in cans may be satisfactorily disposed of by burial. It should be emptied from the cans into trenches 2 to 3 feet deep, or in pits. As a section of the trench is filled, it should be sprayed with

crude oil, or better, dusted with borax and promptly covered to prevent fly breeding.

Latrines.--Since flies breed in and feed upon human excreta, and since the danger of disease organisms being carried by flies that have access to such materials exists, it is extremely important that flies be excluded from latrines. In temporary camps this is not easy. Trench latrines are usually employed in such camps, and flies cannot readily be excluded from them. The prompt covering of the feces with earth by each man tends to exclude the flies, and the free use of crude petroleum or used crankcase oil repels flies to some extent and prevents fly breeding. When the trench is filled to within 1 foot of the top, it should be well sprayed with crude oil or heavily dusted with borax and filled with clean earth. Pit or bored latrines, as used in more permanent camps, may be fitted with standard latrine boxes as issued by the Quartermaster's Corps. These should be kept fly tight and carefully fitted to the soil surface. Daily policing and spraying of the pits with crude oil should be practiced. Fly traps set near the latrines aid in holding down fly breeding and contamination.

Sewage disposal.--It is important to locate permanent camps adjacent to towns or cities with effective and adequate sewage disposal facilities. In large camps the provision of sanitary sewers with approved disposal plants is essential.

Sewage disposal systems must be watched closely to prevent fly breeding. Sludge, especially if not fully digested, is very favorable for fly breeding. Heavy scum on septic tanks and sludge-drying beds often produces great numbers of houseflies. With proper operation of the disposal plants, quick drying of the sludge, and the use

of borax when necessary, fly breeding in these situations, however, can be largely prevented.

Protection of Commissaries, Kitchens, Mess Halls,
and Quarters from Flies

Screening.--All openings in building should be protected with well-fitted screens. Windows should have full-length screens and doors should open outward. The screening should be at least 16 meshes to the inch so as to exclude mosquitoes as well as flies. In moist climates non-corroding metals such as cold drawn copper, bronze, or monel metal are most serviceable. In dry climates painted wire is satisfactory. Painting galvanized wire when it is put up will prolong its life in damp climates.

Fans and electrocutors.--Ceiling fans installed over entryways to mess halls and kitchens aid in keeping flies out.

Electrocuting devices, if of proper construction and carrying 3,500 to 4,000 volts with low amperage, are effective in killing flies that strike them. They are used to some extent in doors and windows and also as out-of-door trapping devices. The initial cost of such equipment is rather high and the odor of the burning flies and the dead flies which occasionally fall on the floor are objectionable features, especially in mess halls and kitchens (see list of manufacturers, Circular 20).

Fly traps.--The use of fly traps is an important adjunct to ordinary procedure in the prevention of fly breeding. Tremendous numbers of houseflies and blowflies may be caught in properly constructed and properly baited traps set in strategic locations.

Extensive experiments have shown the conical-type trap, as shown in Fig. 6, to be the most effective and easily handled. This type of trap will catch on an average more than twice as many flies as traps of the tent type. The traps should be from 12 to 18 inches in diameter, with sides and top built of screen and with a cone reaching nearly to the top. The legs should be about 1 inch long. The frame of the trap may be made of barrel hoops and laths or of galvanized iron. The bait should be placed beneath the trap in a broad, shallow pan about 4 inches less in diameter than the base of the cone, and 1 inch deep. One of these traps, properly baited, will capture about as many flies as an electric grid of somewhat similar size, and the cost of installation is much less.

Any substance attractive to the housefly may be used as bait. Blackstrap molasses, 1 part, and water, 3 parts, makes a convenient and attractive bait. Milk and fruit waste may also be employed.

The traps should be set where flies naturally congregate. This is usually on the sunny side of a building (except in very hot weather) and in places protected from the wind. Kitchens and mess halls usually attract flies in considerable numbers and should have traps set near the doors. The bait pans should be kept well filled and should be washed out about every two weeks. The catch is reduced when the flies become piled more than a fourth of the way up the cone. At such times the trap should be emptied. The live flies in the trap at the time of emptying may be killed by immersing the trap in hot water or by the use of a fly spray. The number of traps required depends on the size of the area to be protected and the abundance of flies.

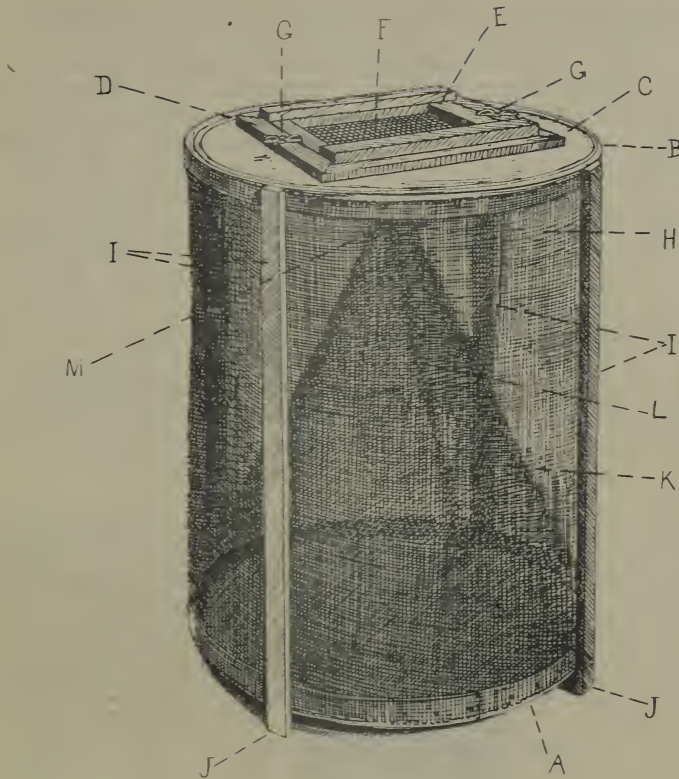


Figure 6 - Conical flytrap, side view. A. hoops forming frame at bottom; B. hoops forming frame at top; C. top of trap made of barrel head; D. strips around door; E. door frame; F. screen on door; G. buttons holding door; H. screen on outside of trap; I. strips on side of trap between hoops; J. tips of these strips projecting to form legs; K. cone; L. united edges of screen forming cone; M. aperture at apex of cone.

Sprays.--Kerosene extract of pyrethrum is effective in killing flies in tightly closed rooms or tents if it is thoroughly applied as a fine mist. The spray should contain the extract of at least 1 pound of pyrethrum flowers with a pyrethrin content of .9% in each gallon. Although this material is not harmful to man, it is advisable to use it only when foods are put away or well protected. An electric sprayer is most effective as an applicator, but large, well constructed hand sprayers, if vigorously plied, will do the work. See specifications on fly sprays (Circular 21) and discussion of spray equipment (Circular 20).

Fly poisons, fly papers, and swatters.--Occasional flies that gain entrance to mess halls, barracks, etc. should be destroyed by using fly poisons, sticky fly paper, and fly swatters.

The safest and most effective poison consists of 3 teaspoonfuls of commercial formalin to 1 pint of milk or water with a little brown sugar added. A convenient way of exposing this is to fill, partly, a drinking glass with the solution. A small plate or saucer is then lined with a piece of blotting paper and placed on the glass, bottom up. The whole is then inverted, and a piece of matchstick inserted under the edge of the glass.

Fly papers, either of the ribbon type or in sheets, are useful in mess halls and kitchens. A convenient way to use these is to tack them to a board provided with a ledge along the bottom to prevent drip, and suspend in out-of-way places where the flies congregate.

BLOWFLIES AND SCREWORMS

Several species of the larger green and bluish-colored flies with metallic sheen and gray flesh flies visit foods and may inoculate them with

dangerous germs. The odor of cooking food, especially cabbage, turnips, and related vegetables, is very attractive to these flies. They may deposit eggs ("blow") on such materials, but are more likely to infest meats, either raw or cooked. Through the swallowing of the living eggs or larvae of some of these flies severe irritation, digestive disturbances, and pain sometimes result (intestinal myiasis). Some of the larvae of these flies also occasionally invade the genital organs (urano-genital myiasis).

The adult of the true screwworm (Cochliomyia americana C. & P.) is bluish green with dark stripes on the thorax, Fig. 7. It closely resem-



Figure 7 - Screwworm fly, female.

bles some of the other blowflies, but it breeds only in living animal tissue. It is therefore of primary importance because of its attack in

the larval form on domestic animals and occasionally on man. Screwworms occur mainly in the South, especially in Texas and Florida, and in Mexico, the West Indies, and Central and South America. Other blowflies occur in nearly all parts of the world. A more detailed discussion of the screwworm is to be found in Circular 18.

BLOWFLY MAGGOTS IN THE TREATMENT OF DISEASE

Since World War I, methods have been developed for treating slow-healing wounds such as chronic osteomyelitis, varicose and diabetic ulcers, and burns with sterile blowfly larvae or certain chemical compounds found in the excretions of these larvae. The species most used for this purpose are the common greenbottle fly, Lucilia sericata Meig., and the black blowfly, Phormia regina Meig. This subject will not be discussed in this National Defense series, but attention is directed to the list of references at the end of this circular.

BREEDING PLACES AND HABITS

Blowflies breed mainly in carrion, although some develop in feces, especially those of man and hog, and in garbage, particularly if it contains meat or meat wastes. The developmental periods in different species of blowflies vary considerably, and they are strongly influenced by temperature. In general, these periods are similar to those of the housefly.

The screwworm breeds only in living, warm-blooded animals. It deposits its eggs on wounds, and the larvae, which hatch in about 12 hours, penetrate into the underlying and surrounding tissues. This results in swelling, inflammation, a bloody discharge, and extensive erosion of these

tissues. In man the nose is frequently the site of attack, although surgical or gunshot wounds, or even minor scratches may become infested if neglected. The larvae complete development in 4 to 10 days, and then drop to the ground to pupate. The life cycle is complete in about 20 days. These flies may travel many miles from where they emerge.

CONTROL

Refrigeration and screens play an important part in protecting foods, especially meat, from flies.

Disposal of Dead Animals

Prompt disposal of carcasses by burning is the most important step in blowfly control. This can be accomplished more easily where wood is plentiful by using the trench method. This consists of digging a trench about the size of the body of the animal, filling this with wood, turning the carcass over on the wood, and lighting a fire at the windward end, Fig. 8.

In cases where prompt burning or burial of carcasses is impractical, the breeding of flies in them and the odor emanating from them may be prevented by spraying them with creosote oil having a tar acid content of at least 10 percent. Incinerators may be used if available.

Garbage Disposal

Garbage should be kept in fly-tight cans and removed daily. Proper handling of garbage at disposal plants and at hog-feeding farms is important. These matters are discussed under housefly control.

Traps

Conical fly traps, similar to those described for use against houseflies, page 11, are useful in supplementary control measures. The legs may be blocked up so as to give about a 2-inch clearance under the cone. Meat scraps, liver, or better, "gut slime" (a packing house by-product of sausage casing manufacture) kept moist with water, are good baits.

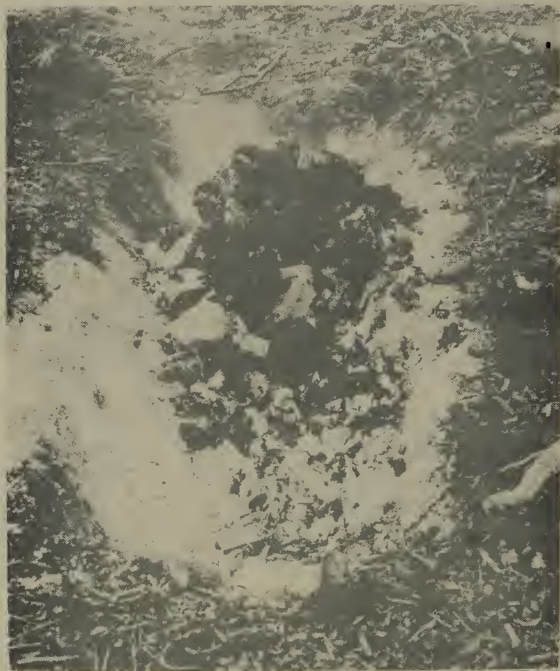


Figure 8 - Burning carcass by the trench method. The carcass is consumed in a few hours by putting the wood in a trench and turning the carcass over on it, then starting the fire at the windward end.

Treatment of Screwworm Infestations

Screwworm infestation should be avoided through personal hygiene and by sleeping during the day only behind screens or under nets. Animal infestation can be avoided by preventing the occurrence of wounds as far as possible, and when they do occur, treating them every three days with powdered diphenylamine. See also Circular 18.

In the case of human infestations, the larvae may be removed with forceps after a judicious application of chloroform applied with an atomizer. Infested wounds in animals are treated by killing the larvae with benzol (preferably applied as a spray), carefully removing the larvae, and packing pulverized diphenylamine crystals into the wound. If diphenylamine is not at hand dehydrated acid-free pine tar oil with a specific gravity of 1.065 should be applied each day to the wound to repel the flies.

HUMAN BOT INFESTATIONS

A number of different species of flies normally parasitic on domestic or wild animals occasionally attack man. The most troublesome of these is the human bot, Dermatobia hominus, Fig. 9, of tropical America. The horse bots and cattle grubs also attack man on occasion, sometimes producing grave symptoms. Horse bot infestations in man usually take the form of skin invasions (dermal myiasis). These are not difficult to deal with. Further information on horse bots is contained in Circular 16.

THE HUMAN BOT

This parasite, known in tropical America as "berne" or "torcel," is a common pest of cattle, hogs, and various other domestic and wild animals from central Mexico through Central America and over much of South America. It infests the skin, forming swollen, discharging lesions. The infestations of man occur mainly on the exposed parts.



Figure 9 - Human bot fly.

The pest has not been thoroughly investigated or methods of control worked out. It is known that the fly at least sometimes attaches its eggs to the bodies of other insects such as mosquitoes or other flies, Fig. 10. When these latter insects chance to alight on a person or other warm-blooded animal the eggs hatch and the bots, Fig. 11, penetrate the skin.

Prevention and Treatment

No control procedure has been developed. Infestations may be held down by keeping the person protected as much as possible from the attack of biting insects.

When infestations occur, the larvae may be squeezed out or killed by applying benzol or chloroform to the openings through the skin, after which the larvae should be removed and an antiseptic applied to the point of attack.



Figure 10 - Eggs of human bot fly attached to the abdomen of another fly.

THE EYE GNATS

Eye gnats (Hippelates) are very small (about $1/16$ inch long) black or yellowish flies that have a strong tendency to hover around the face and eyes of people and also to visit food to some extent. They are strongly attracted to wounds and discharges from natural body openings. They also feed upon garbage and excreta, and hence are capable of taking up and transferring

many kinds of germs. There is abundant evidence that they are responsible for much eye infection and may transmit the serious tropical disease of man called yaws.



Figure 11 -
Larva of
human bot
fly (after
Ward).

Eye gnats are most abundant in the southern portions of the country, and in the irrigated areas in the Southwest they may occur in alarming numbers.

These gnats are so small that they can pass through ordinary screens with ease. They prefer bright light; therefore, are not very troublesome in buildings except in rooms with many windows or on porches.

BREEDING PLACES

Eye gnats breed mainly in cultivated soil containing decaying vegetation and manure. They prefer the lighter types of soils and those with considerable moisture. They may breed to some extent in garbage and are attracted to places protected from strong winds and to the shade in hot weather.

CONTROL

Little can be done by military units to prevent breeding. Reducing the cultivation of the soil to a minimum around camps should reduce breed-

ing in the immediate area. The eggs are laid on the soil very soon after it is broken by plowing or cultivation. Breaking, harrowing, and rolling the soil in one operation appears to reduce breeding. Keeping attractive materials, such as manure and garbage, covered and removing them frequently is an aid in control.

Traps of a special design, Fig. 12, placed around the camp in places where gnats occur in



Figure 12 - An improvised eye gnat trap. The liver and water bait is placed in the bottom of the can, and the gnats, after feeding, enter the jar and die.

greatest numbers will reduce gnat abundance to a large extent. Systematic operation of traps around schools has been shown to aid materially in the reduction of the incidence of purulent conjunctivitis.

Fly sprays (pyrethrum in oil) kill the gnats actually struck and repel others for a short time. Pyrethrum concentrate (1-20*) and lubricating oil (No. 10), 20 parts, lightly painted on window screens will keep gnats out for several hours. This is particularly useful in infirmaries.

A light application of fly spray to the face and garments will repel the gnats for a short period.

BLOOD-SUCKING FLIES

There are many different kinds of blood-sucking flies. Some of these are of considerable importance as annoyers of man and livestock, and they are of some importance as transmitters of disease. Their role in the transmission of disease in the Americas is mainly of a mechanical or accidental nature. Anthrax and tularemia, or rabbit fever, are the maladies with which they are most frequently associated. These diseases are transmitted to both animals and man by horse flies and deer flies (family Tabanidae). It is probable that stable flies, Stomoxys calcitrans, Fabr., also occasionally transmit these maladies. These flies are often extremely annoying by their painful bites (see Circular 17). Buffalo gnats, or black flies, (Simuliidae) are abundant and annoying locally. They are not known to transmit any disease in the United States; however, in parts of Mexico and Central America certain species transmit the worm Onchocerca which causes a serious disease of man often resulting in blind-

*Extract of 20 lbs. pyrethrum in 1 gallon of kerosene.

ness. Sand flies (Culicoides) are extremely troublesome to man and livestock in certain regions.

The flies referred to above have very different breeding habits, and the control procedure must vary accordingly. Where trouble is experienced, specimens of the fly causing the difficulty should accompany requests for further information.

HORSE FLIES AND DEER FLIES

Horse flies, Fig. 13, and deer flies, Fig. 14, breed in marshes or swamps, along streams with marshy banks, and in meadows over which irrigation water is allowed to run continuously. Location of camps on well-drained sites away from marshes, improved drainage and clearing, and the use of screens are the methods of control or protection which have to be relied upon. Repellents are practically valueless against horse flies.



Figure 13 - A horse fly, Tabanus atratus F.



Figure 14 - A deer fly, Chrysops nigra Macq.

BUFFALO GNATS, OR BLACK FLIES

Buffalo gnats, or black flies, Fig. 15, are small heavy-bodied flies that breed in running water. The larvae attach to sticks, stones, and other objects in the swiftest portions of streams, and the gnats often emerge in swarms. There is usually a single brood each year, and fortunately the season of activity is rather short.

Control measures have not been well worked out. Removal of stones and brush from streams reduces the opportunity for breeding. The treatment of small streams near camps with pyrethrum larvicide (see Circular 21) will destroy the larvae. Nets or screens should be placed across the stream to prevent fish that may be stunned by the insecticide from floating downstream with the material. The dosage required under different stream condi-

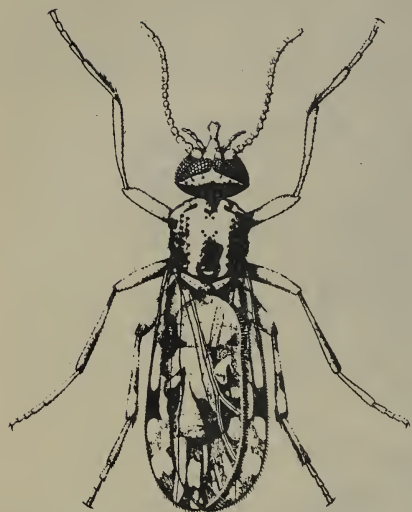
tions has not been determined. Smudges give both man and livestock some protection, and pyrethrum concentrates, mixed with No. 10 lubrication oil 1 to 5, mopped or sprayed on, give some relief.



Figure 15 - Adult black fly.

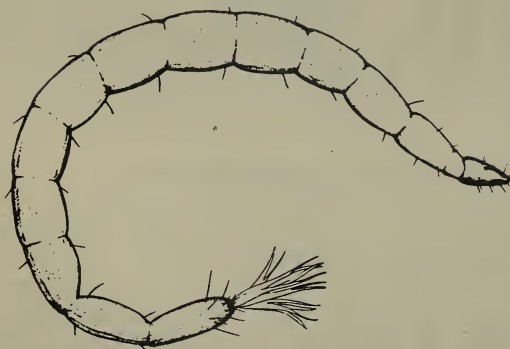
SAND FLIES, OR PUNKIES

Minute biting midges, Fig. 16, known as sand flies, punkies, or no-see-ums, are troublesome pests of man and livestock in many parts of the country. There are many different species, and these show destructive breeding habits.



All breed in water or very damp places. The larvae, Fig. 17, of certain species are to be found among leaves and other decaying vegetation or in manure along the margin of streams. Others breed in rot holes in trees that are capable of holding water.

Figure 16 - Adult sand fly.



The most serious annoyance from these pests occurs along the Atlantic and Gulf Coasts and in the West Indies and Central American countries. These

Figure 17 - Larva of sand fly.

pests breed in open, grassy salt marshes where the tide is not too active, also in mangrove and pickleweed marshes along the coast of Florida and countries to the south. Breeding is more profuse in areas where fresh water enters the sea.

Biology

The eggs, Fig. 18, are laid on the mud near the water. They hatch in a few days, and the slender larvae can either burrow in the thin mud or swim about in the water. The larval stage varies from a few months to 6 or 8 months. Pupation, Fig. 19, takes place in the mud. Sand flies apparently do not spread more than 2 or 3 miles from their point of emergence.



Figure 18 - Eggs of sand fly.

Figure 19 - Pupa of sand fly.

Control

Sand fly larvae are susceptible to drying; therefore, removal of water from a breeding area is the most satisfactory control. Unlike mosquitoes, they can live in mud, so more complete drying is necessary than is required in mosquito control.

It has been found possible to largely eliminate the pest by construction of dikes around prolific breeding areas and removing the water from behind the dikes by tide gates or pumping, or both. In order to concentrate the water and more completely dry the diked area, a ditching system is usually necessary. Since some sand flies develop in the mud along the ditches, the number of ditches should be reduced to a minimum, and these should lead directly into the large band ditch running along the dike.

Woods adjacent to camps should be inspected, and rot holes found should be cut out so they will drain, or they may be sprayed or painted liberally with creosote oil.

Sand flies can pass readily through ordinary screens, and thus they often become very annoying in well-screened buildings. This can be prevented by painting the screens lightly each evening with 1 part of pyrethrum concentrate (20 to 1) in 20 parts of light lubricating oil (S.A.E.5).

This repellent mixture may be applied to exposed parts of the body to protect against sand fly attack. Oil of spearmint or oil of sassafras is also of some value as a repellent.

The location of camps on areas well removed from sand fly breeding places is advised, and placing the camps in exposed places is helpful since sand flies are not troublesome in a strong breeze. Sand flies are attracted to light to some extent; therefore, on still nights when these gnats are bad, illumination of quarters should be avoided as much as possible.

STABLE FLIES, OR DOG FLIES

Stable flies, dog flies, or biting houseflies (Stomoxys calcitrans Fabr.), Fig. 20, as they are variously known, are grayish flies resembling the common housefly, but slightly more robust and with a strong blood-sucking beak. They breed in manure and many kinds of fermenting vegetation. They are produced in tremendous numbers in straw mixed with urine and manure of horses, cattle, or hogs, in straw stacks that have become wet by heavy rains soon after thrashing, in seaweed washed up on beaches under certain conditions, and in large accumulations of weeds, hay, manure, and other debris left in fields or deposited by floods.



Figure 20 - The stable fly,
Stomoxys calcitrans.

Caring for manure and other vegetable refuse as recommended for the housefly will largely prevent stable fly development in such material. These flies travel considerable distances, and the cooperation of farmers and others in the vicinity of the area to be protected is therefore necessary for best results. This fly is not captured in any numbers in traps designed to catch houseflies and blowflies; however, electric grids, if

properly placed, especially in windows of stables containing livestock, will destroy large numbers of them. Repellents are of little value, but these flies are very susceptible to pyrethrum-oil sprays if they can be struck by the spray. Further details on control are given in Circular 17.

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